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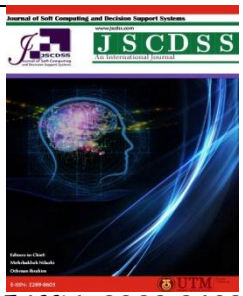

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How Mindset Stimulating Media affect Blood Pressure

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Abstract

The objective of this experiment was to demonstrate how blood pressure responses in human subjects to the consumption of mindset stimulating media. There is little evidence concerning a clear demonstration of blood pressure control in human subjects based on different emotion evoking information. We create the hypothesis that mindset shows significance in blood pressure control as a method to prevent hypertension in a domestic scale. High blood pressure is globally a major health problem and a growing obesity related health factor accounting nearly 30 % of the world population. In order to control hypertension we used mindset influencing information consisting of different emotion stimulating media, which were presented to 15 subjects while blood pressure was continuously measured. The experiment was conducted in a weekly frequency within 6 months. It can be obtained that 42 % of high blood pressure subjects showed the increment of systolic values. For diastolic values, the increment was recorded as 37 %. In total, 44 % of all subjects showed the ability to decrease their systole and 39 % were able to change diastole values while consuming presented media. Lastly, some subjects were able to maintain their blood pressure after the experiment ended with a distribution of 14 % for systolic and 24 % for diastolic values. In conclusion, it can be stated that hypertension subjects are able to reduce their blood pressure during media consumption but are not successful in stabilizing their blood pressure after the interaction with blood pressure influencing media ended. In contrast to that, normal blood pressure subjects require less time to return to their normal blood pressure values and therefore, to their normal health condition. These results are an introduction to a novel method in preventive hypertension control based on home based media consumption.

Keywords: Blood pressure, Control, Emotion, Hypertension, Media consumption, Mindset, Obesity related disease

1. Introduction

The rising prevalence of obesity and overweight related diseases like hypertension and consequent cardiovascular complications has brought concern about South East Asia's health status. According to the latest clinical statistics, approximately every second Malaysian citizen falls into the obesity category, whereas the reference to global obesity rates accounts less than every third person to be overweight (Ng et al., 2014). Moreover, according to the National Health and Morbidity Survey (NHMS) 2011, hypertension was diagnosed in 32.7 % of Malaysian adults. Out of one third of all positive diagnosed hypertension subjects in Malaysia, only 41 % had knowledge about their critical health condition. This means that the majority of Malaysia's hypertension affected population is lacking in knowledge about their own health condition and therefore its consequences. It would be possible to monitor respective information via mobile devices (Nilashi et al., 2015). Since hypertension may lead to myocardial infarction and other related diseases (James et al., 2014), the government of Malaysia is confronted with an increasing outage of workforce when ignoring this situation. There are approaches towards the evaluation of Malaysian government portals which could be combined with the purpose of providing access to workforce related health data (Nilashi et al., 2012; Aditya et al., 2013; Aditya et al., 2014; Jalil et al., 2014). Moreover, health platforms could be organized with specific parameters in order to provide health data electronically in a national context from private and public health care centers to the public level of statistics and data processing (Ahmadi et al., 2014; Ahmadi et al. 2016; Pahl et al., 2015h; Zare et al., 2015). According to McKinsey Global Institution, obesity impacts global costs of US$ 2 trillion in healthcare and loss of productivity.

In order to counteract this national problem, we develop the hypothesis that blood pressure is dependent on mindset and therefore, the manipulation of mindset by using specific media can affect blood pressure and decrease hypertension induced health problems.

1.1 *Mindset Based Blood Pressure Control*

A substantial body of literature on blood pressure focusses on the physiology and pharmaceutical treatment. Blood pressure has two significant pressure values which are systolic and diastolic. The systolic value indicates high arterial pressure during the cardiac contraction. However, the diastolic value refers to low arterial pressure during relaxation. Blood pressure is active and can vary by time. It constantly changes due to environmental factors and physiological stimuli (Larkin, 2008). Blood pressure is commonly expressed in the unit mmHg and is depending on cardiac output (CO) expressed in mL blood/min, which is the volume of blood pumped by the heart per minute and total peripheral resistance (TPR) expressed in $mmHg \cdot min \cdot mL^{-1}$, representing the vascular resistance of the systemic circulation. The main factors to steer the cardiac output are heart rate (HR), measured in blood pressure and stroke volume (SV) measured in cm^3. Stroke volume is the amount of ejected blood in one contraction of a ventricle. The formula to calculate blood pressure is shown in Eq. (1) and Eq. (2) (Chandran et al., 2012).

$$BP = CO \times TPR \quad (1)$$

$$CO = HR \times SV \quad (2)$$

SV, however, is influenced by the amount of adrenaline (epinephrine) and nor-adrenaline (norepinephrine) hormones (Levick, 1991). The increase of these hormones leads to the increase of stroke volume. Adrenaline, as the activator for the body has the ability to affect the nervous system that in turn controls the regulation of heart beat. The effect of this hormone takes short time. Moreover, nor-adrenaline is released by the sympathetic nervous system as a response to mental strain, also known as stress. Everly et al. provide a clinical guide to the treatment of the human stress response (Everly et al., 2012). Nor-adrenaline causes vasoconstriction in systemic blood circulation. This, however, increases the total of peripheral resistance and blood pressure. In Fig. 1, blood pressure was taken six times every 50 seconds. It can be obtained that blood pressure varies by time.

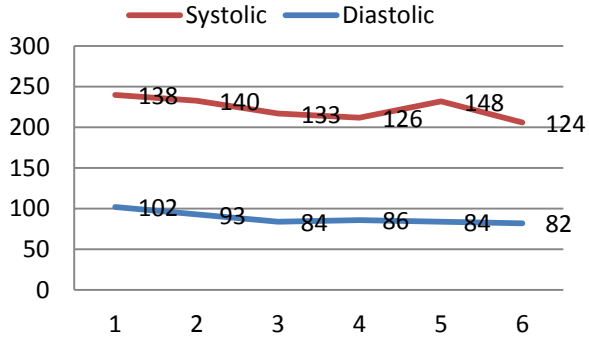

Fig. 1. An example of the variation of blood pressure by time.

Literature on blood pressure control using mindset, however, is far less extensive. Mindset was already observed to be capable to control physiological changes (Crum et al., 2007). However, mindset behaviors are influenced by experience and mentality and may differ among individuals. The emotion of fear, for example, relates directly to the secretion of hormones like adrenaline. Here, the hypothalamus plays an important role. As one structure of the brain, it is assumed to be the source of emotions (Masserman, 1941). This is due to the fact that it produces master gland, which causes feelings and emotions. Feelings depend on environment stimuli and therefore underlie changes.

Since decades, different techniques are used to describe the impact of mindset influencing methods (Cahn et al., 2006; Jevning et al., 1992; Pase et al., 2013). Mindset influence is reported to cause the reduction of anxiety as reported in (Aftanas et al., 2003; Carlson et al., 2004; Lane et al., 2007). Kabat-Zinn developed mindfulness based stress reduction, which has been applied on both, healthy subjects as well as subjects with mental or physiological diseases (Kabat-Zinn, 2003). There are several analysis methods to understand brain activities during mindset influence (Ng et a., 20014; Takahashi et al., 2005; Cahn et al., 2006; Aftanas et al., 2003; Lewis et al., 2007; Fell et al., 2010). The anterior cingulate cortex is an important part in the limbic lobe for cognitive progress. It appears to regulate the autonomous nervous system such as blood pressure and heart rate (Toga et al., 2003; Bush et al., 2000; Pase et al., 2013; Kitayama et al., 2015), The vegetative nervous system controls and stimulates instinctive and unconscious organ functions, which regulate the vascular system, blood pressure, digestive system and heart lung cycle (Gray et al., 1974). Basically, mindset stimulation impacts the self-regulation of body and mind so that mental processes can be under greater control and reach specific subjective experiences such as restful and heightened alertness (Cahn et al., 2006). Research about the importance of blood pressure reactivity and recovery examination in anger provocation setups represents a related field (Anderson et al., 2005). Moreover, the emotional response during daily life has been analyzed and described with reference to psychosocial functioning and ambulatory blood pressure (Carels et al., 2000). Further research has been performed analyzing the relation between depressed mood and blood pressure in the context of the moderation of the effect of situation-specific arousal levels (Davydov et al., 2012).

One work by Hallas et al. aimed at predicting blood pressure reactivity and heart rate variability from the mood state (Hallas et al., 2003). A further work describes the conditioning of human blood pressure response (Reiff et al., 1999). A different procedure setup used oscillatory EEG concomitants of emotional blood pressure reactivity for the mental imagery of personally salient events (Reva et al., 2008). Placebo effects were tested on blood pressure, heart rate, well-being and cognitive performance using caffeine placebo and suggestion (Wallach et al., 2002). Different methodologies have been used to measure the effect of mindset stimulation on the human body (Takahashi et al., 2005; Cahn et al., 2006; Fell et al., 2010; Tang et al., 2009; Vedhara et al., 2003; Barnhofer et al., 2010; Walach et al., 2002). Our experiment uses the direct

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measurement of blood pressure in order to validate the effect of mindset influence on blood pressure values.

1.2 Prevalence of Hypertension and Rates and Solution

Due to the prevalence of demographically increasing hypertension rates, a method is required to counteract high blood pressure and consequent cardiovascular diseases. Our hypothesis is that mindset influencing media impacts the anterior cingulate cortex and regulates therefore autonomous nervous system functions such as blood pressure. In contrast to other literature, our method is based on blood pressure measurement in relation to consumed media and therefore a direct indicator for the impact of mindset influencing information. The objectives of our study are as follows:

- Presentation of a procedure for the measurement of media related blood pressure values.
- Validation of blood pressure values in the context of specific emotion provoked information setups.
- Evaluation of presented method for a home based application in the context of health education (Elyazgi et al., 2016).

2. Materials and Methods

In this research, a total of 15 subjects underwent the test procedure. 73 % of the test subjects showed a healthy blood pressure condition, whereas the other 27 % were diagnosed with hypertension. Among the test subjects, different educational backgrounds were represented. This research aims to investigate if mindset influences blood pressure, to analyze what type of information effects the increment or decrement of blood pressure, to define information, which affect blood pressure the most and to develop test procedures for different subject groups.

2.1 Prevalence of Hypertension and Rates and Solution

Before test procedures started, informed written consent was collected from all participating subjects. Subsequently, tests were carried out in a room, where external stimulants to the senses of each subject were exerted with the intention to stimulate the subject's brain. Simultaneously to the consumption of stimulating information, the subject's blood pressure was measured. We used the iHealth Wireless Blood Pressure Wrist Monitor (BP7) and transferred data via Bluetooth V3.0. Data was collected and analyzed using Microsoft Excel 2013 as well as MATLAB R2014a. We specifically designed a procedure to receive external stimulant responses effectively. External stimuli that we used to affect the mindset of our subjects were of acoustic and visual nature including video, photo, text material and audio material. Media was combined into one movie and presented subsequently over 60 minutes to each subject. We aimed at defining a specific type of information, which greatly affects the mindset of test subjects, which in turn was expected to influence blood pressure. Each information type consisted of different genres being; (1) funny, (2) horror, (3) sad, (4) calm (peaceful) and (5) boring.

Doing so, we could observe, which genre triggered through the influenced mindset an increases or decreases of blood pressure. Before and during the experiment, subjects were instructed to lie down for 5 minutes time in order to relax. This caused previous factors like arrival stress to relieve and adjust the mental condition for all participating subjects. During each test, the blood pressure was continuously recorded and average blood pressure values were calculated for each consumed genre. Recorded data were compared, analyzed and conclusions made.

2.2 Prevalence of Hypertension and Rates and Solution

The procedure of this experiment is explained in this section. First of all, the subject comes to the sound lab and signs the consent letter. A wireless blood pressure monitor is attached to his or her wrist. After this step, a relaxation time of 5 minutes is provided and the blood pressure gets measured as shown in Fig. 2.

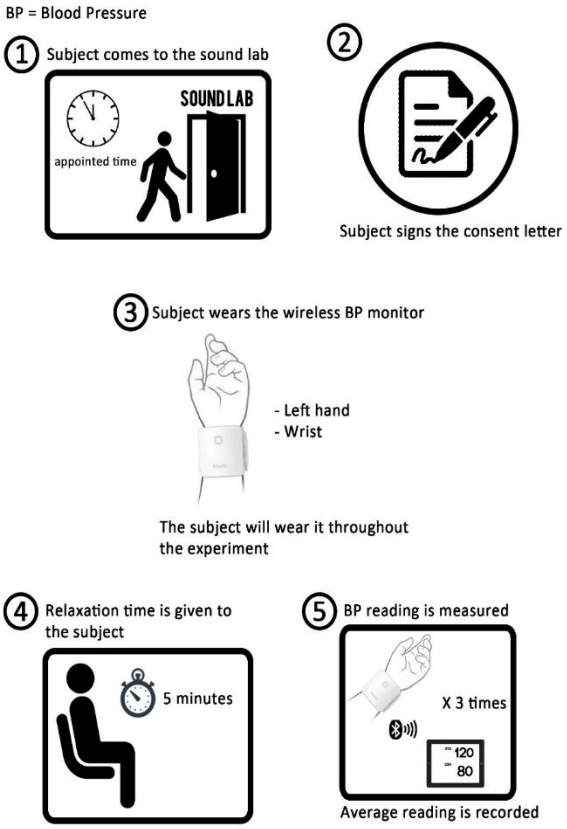

Fig. 2. Test preparation, procedure steps 1 to 5. (1) Subject comes to the sound lab, (2) signs consent letter, (3) wears wireless blood pressure (BP) monitor, (4) relaxes for 5 minutes and (6) and blood pressure gets measured.

Subsequently, the main procedure is carried out. Information input is done using a personal computer. Each input contains 5 genres. After the consumption of each genre, a relaxation time of one minute without any further information input is provided. This can be obtained from Fig. 3.

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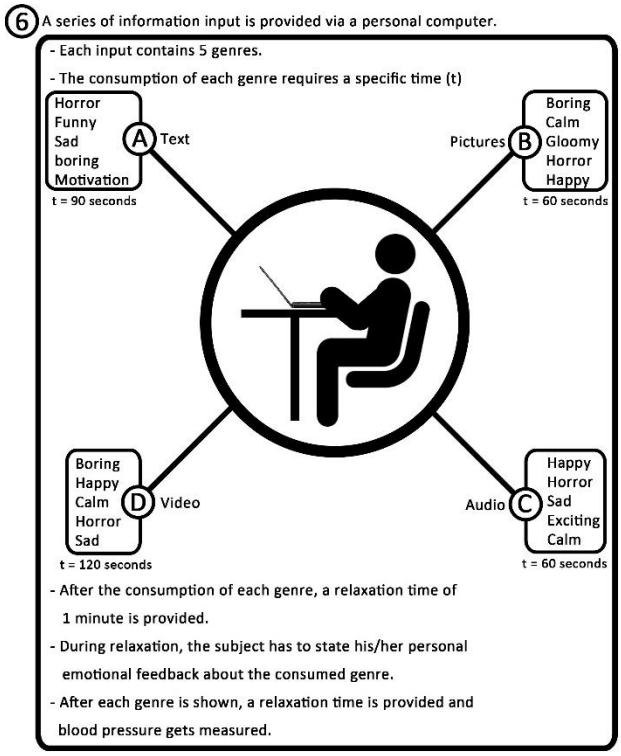

Fig. 3. Test execution, procedure step 6. Information input using personal computer. Each input contains 5 genres. After the consumption of each genre, subjects are relaxing for one minute without any information input.

Finally, the post procedure consisting of steps 7 to 9 is performed. First, the subject relaxes for 5 minutes, then the blood pressure gets measured and the blood pressure monitor gets removed. This can be obtained from Fig. 4.

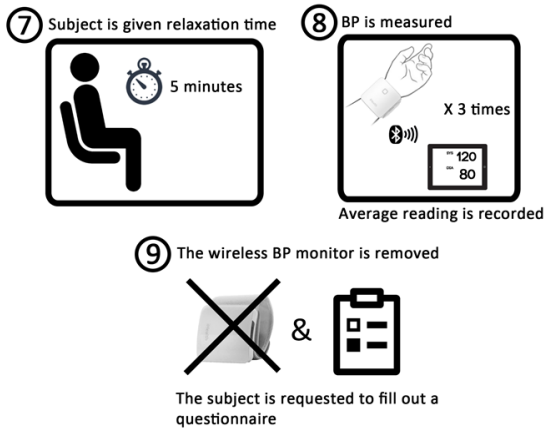

Fig. 4. Post procedure steps 7 to 9. (7) Subject is relaxing for 5 minutes, (8) Blood pressure gets measured and (9) blood pressure monitor gets removed.

3. Results

In order to analyse the impact of mindset on blood pressure, we calculated the range of blood pressure increment and decrement. The formula used to calculate the average increment range for each category can be obtained from Eq. ()3 (see the graph in Fig. 5 as the illustration of the calculation):

$$\sum \frac{HV - IV}{NoSCatA} \quad (3)$$

Here, the sum of the highest value (HV) being subtracted from the initial value (IV) and divided by the number of subjects for category A (NoSCatA) is calculated. Whereas, for average decrement, the range for each category can be calculated using Eq. (4) with the lowest value (LV).

$$\sum \frac{IV - LV}{NoSCatA} \quad (4)$$

Since blood pressure varies in all individuals, we assume that the initial blood pressure value is the indicator for our formula. We developed this formula in order to see the difference of increment and decrement of blood pressure values when compared to the initial point. Moreover, blood pressure average values based on changes of the subject's blood pressure were calculated and results tabulated in Table 1. The range shows that all systolic values of increment and decrement in both categories are higher than diastolic values. It can be concluded that blood vessels are contracted and not relaxed.

Table 1
Increment and decrement of averaged blood pressure values.

		High blood pressure	Normal Blood Pressure
Systole	Increment	12.00	10.73
	Decrement	08.50	11.73
Diastole	Increment	06.75	10.45
	Decrement	08.00	09.64

3.1 Analysis of Differences between Subjects with High and Normal Blood Pressure

There are differences between a person with normal blood pressure and high blood pressure. An individual with high blood pressure can be categorized as a hypertension subject. From this case study, we have analyzed the increment, decrement and constant measurement of blood pressure between each relaxation period by referring to the results of each subject. Then, we calculated the percentage of these three references (increased, decreased and constant). The differences between both subject groups (high and normal blood pressure) were compared by calculating the average percentage of all high blood pressure and normal blood pressure subjects, respectively. From Fig. 6, it can be obtained that 38 % of normal blood pressure subjects showed increased values for systole and diastole.

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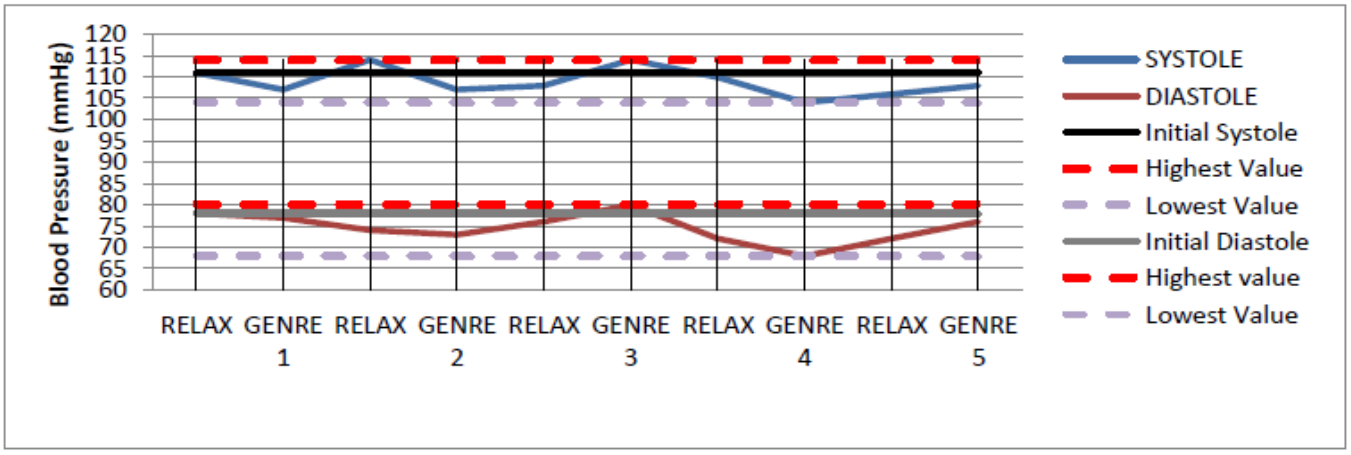

Fig. 5. Difference of Increment and Decrement of Blood Pressure from Initial Point.

In this measurement series, 42 % of normal blood pressure subjects had a decrement of systolic and diastolic values between each information genre while the rest remained unchanged. In contrast to that, 42 % of high blood pressure subjects showed the increment of systolic values. For diastolic values, the increment was recorded as 37 %. In total, 44 % of all subjects showed the ability to decrease their systole and 39 % were able to change diastole values. Lastly, some subjects could maintain their blood pressure with a distribution of 14 % for systolic and 24 % for diastolic values. In conclusion, it can be stated that high blood pressure subjects showed a greater tendency to increase their blood pressure by mindset. This shows that high blood pressure subjects have problems in stabilizing their normal blood pressure after interacting with blood pressure influencing information. In contrast to that, normal blood pressure subjects require less time to return to their blood pressure values and therefore, to normal condition.

3.1 Analysis of Data by Genre

The analysis of blood pressure results in relation to consumed mindset influencing information is represented in Fig. 7. For each information type, we have chosen three genres and grouped them into: happy, sad and horror. Fig. 8 until Fig.10 show the data analysis for three different types of mood stimulating data sets being Happy, Sad and Horror. The letter 'M' stands for the calming down of the subjects mood. Values reach initial blood pressure values. 'L' stands for the calming down without reaching initial blood pressure values. 'N' represents the unsuccessful calming down of the patient's mood.

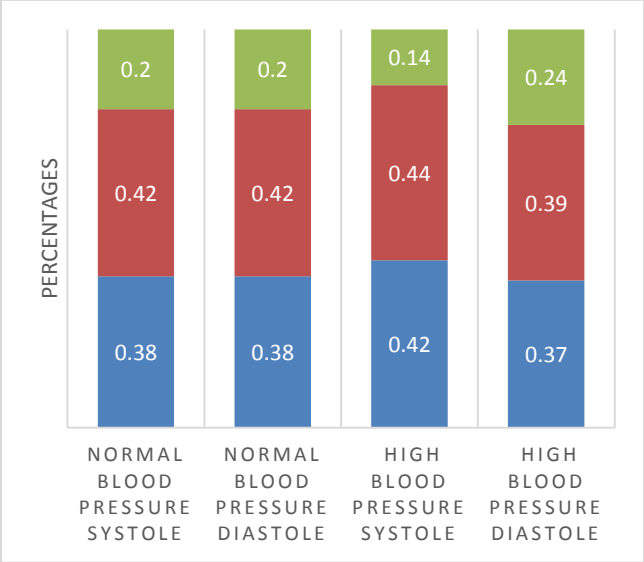

Fig. 6. Increase, decrease and constant blood pressure values in percentage.

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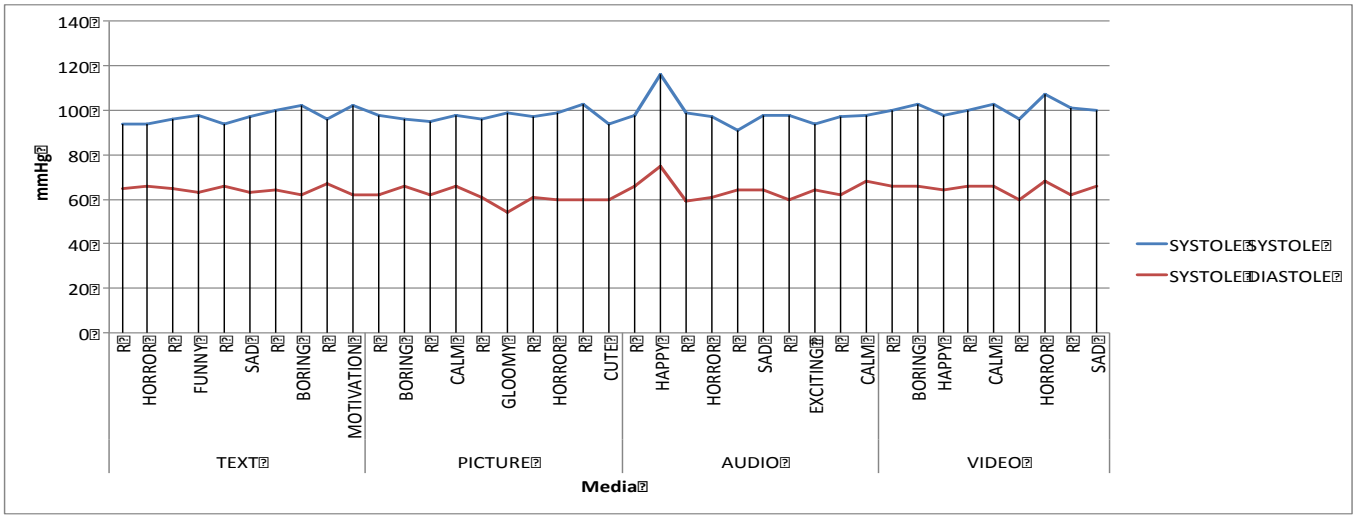

Fig. 7. Subjects showed specific blood pressure conditions in relation to information consumption. M: Increase to values higher than initial status. L: Decrease to values lower than initial status. N: No decrease or increase to initial values. Blue line represents systolic and red diastolic values.

It can be concluded that there is a faster reduction of abnormal high blood pressure after receiving information from the happy genre.

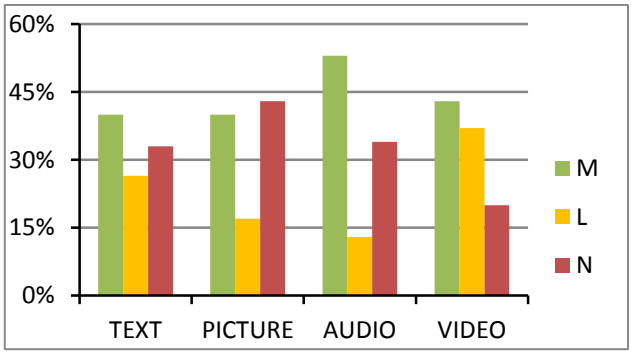

Fig. 8. Effects for 'Happy' stimulating data. The letter 'M' stands for the calming down of the subjects mood. Values reach initial blood pressure values. 'L' stands for the calming down without reaching initial blood pressure values. 'N' represents the unsuccessful calming down of the patient's mood.

From Fig. 9, it can be obtained that happy audio information had the highest impact on our subjects leading to the stabilization of blood pressure to normal condition compared to other consumed information types. Although, audio information increases or decreases the blood pressure after short time post to consumption, the blood pressure returned quickly to its original values. Moreover, we can observe that sad information shows the most negative impact on blood pressure values. In most cases, subjects could not successfully decrease their blood pressure values by consuming sad information. Same goes to Horror information. These results were taken after information consumption during 1 minute.

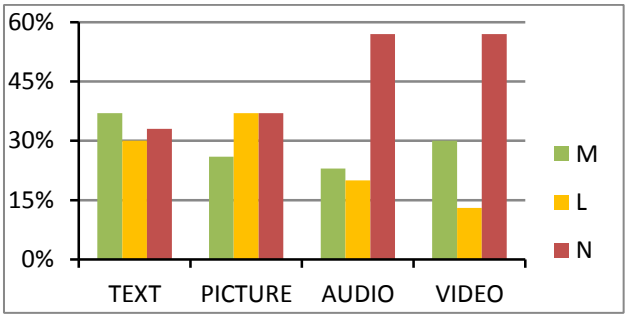

Fig. 9. Effects for 'Sad' stimulating data. The letter 'M' stands for the calming down of the subjects mood. Values reach initial blood pressure values. 'L' stands for the calming down without reaching initial blood pressure values. 'N' represents the unsuccessful calming down of the patient's mood.

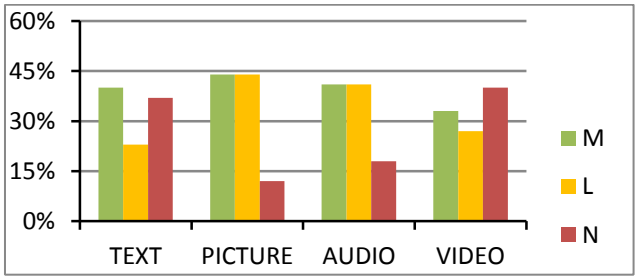

Fig. 10. Effects for 'Horror' stimulating data. The letter 'M' stands for the calming down of the subjects mood. Values reach initial blood pressure values. 'L' stands for the calming down without reaching initial blood pressure values. 'N' represents the unsuccessful calming down of the patient's mood.

4. Discussion

The major finding of this experiment was that the blood pressure response in humans could be systematically controlled by stimulating the brain with different media consisting of visual and acoustic information. This finding, however, is compromised by the observation that the consumption is statistically significant using happiness transmitting media, rather than the intuitively expected calming information.

We could observe that mind-set does influence individual blood pressure values. However, during the experiment, some difficulties were noticed. This case study was conducted in a period of 6 months only and may be improved by a more horizontal approach. We observed intra-subjective differences in the personalities among our subjects. These differences range from outgoing and extroverted up to very nervous and introverted personalities. In order to maintain comparable results, we assimilated the conditions of each subject during the test to a state of relaxation. This helped to reduce personality and environmental experience related affects to the test. The small number of subjects, who were diagnosed with high blood pressure, may be used to prove the hypothesis only. Moreover, the imbalanced distribution of normal blood pressure and high blood pressure subjects impacts the statistical calculations of our results. Therefore, we applied the accuracy calculation as shown in Eq. (5) with 11 normal blood pressure and 4 high blood pressure subjects resulting in 26 %. A higher number of high blood pressure subjects would automatically lead to a higher accuracy of statistical comparison. However, in this setup the aim was to show that mind-set has influence on blood pressure independent from the actual effect distributed among the subjects.

$$Accuracy = \frac{No.of\ clients\ of\ HBP}{Total\ no.of\ clients\ of\ HBP\ and\ NBP} \times 100\% \quad (5)$$

Although, we could successfully show that sensory influencing information does have an impact on individual blood pressure values, we suggest future works on this field to compare the change of blood pressure by sensory information consumption and physical activities. Moreover, differences or similarities between consumed media can be investigated in a deeper scale in order to determine, which data set is most effective in influencing blood pressure values. A neurological approach may be utilized to investigate which information set influences respective brain parts in the context of blood pressure control. This approach may provide information about data, which remain the effects of blood pressure manipulation after interrupting the sensory information supply. We also consider some improvements of our work, which include a test setup providing a higher number of subjects with a balanced distribution between high blood pressure and normal blood pressure subjects. Collaborations with medical institutions may support the execution of the horizontal approach of this study. Furthermore, the procedure room should be free of noise in order to reduce errors. Lightening and temperature play another important role and should be adjusted for all procedures in the same way. We performed surveys about our test procedure to the participating subjects. Based on these surveys, a few suggestions can be made to improve the quality of this research. These suggestions include:

- Questionnaires should be in a psychometric scale like the Likert response scale instead of yes-no scale.
- The display for visual information consumption should be bigger to increase information impact on the subjects.

5. Conclusion

Based on these research results, we conclude that mindset does influence the values of blood pressure. It can be obtained that 42 % of high blood pressure subjects showed the increment of systolic values. For diastolic values, the increment was recorded as 37 %. In total, 44 % of all subjects showed the ability to decrease their systole and 39 % were able to change diastole values while consuming presented media. Lastly, some subjects were able to maintain their blood pressure after the experiment ended with a distribution of 14 % for systolic and 24 % for diastolic values. In conclusion, it can be stated that hypertension subjects are able to reduce their blood pressure during media consumption but are not successful in stabilizing their blood pressure after the interaction with blood pressure influencing media ended. In contrast to that, normal blood pressure subjects require less time to return to their normal blood pressure values and therefore, to their normal health condition. These results represent an introduction to a novel method in preventive hypertension control for home based media consumption.

6. Related projects

Our research groups mainly focus on imaging technologies like ultrasound with a variety of applications. Therefore, several projects in this area have been carried out (Jeffree et al., 2013, Lam et al., 2014, Nordin et al., 2014, Pahl et al., 2012a, Pahl et al., 2012b, Surakusumah et al., 2014, Seng et al., 2013, Tan et al., 2012, Vadival et al., 2013, Pahl et al., 2012c, Pahl et al., 2014a, Pahl et al., 2013a, Pahl et al., 2015j). Further work deals with the automation and remote control of ultrasound machines and other automated systems (Kho et al., 2014, Pahl et al., 2015a, Pahl et al., 2015b, Pahl et al., 2015i, Rizqie et al., 2014, Pahl et al., 2015f, Pahl, 2015i, Pahl et al., 2015b, Pahl et al., 2015c, Pahl et al., 2015e, Zarate et al., 2015). Furthermore, some approaches have been developed on the field of health informatics (Pahl et al., 2015g, Pahl et al., 2014b, Pahl et al., 2014c, Pahl et al., 2015h). Finally, approaches have been tested on the field of visual perception (Pahl et al., 2015d). Future works focus on system engineering concepts of automated ultrasound systems.

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